Valuing the Economic Benefits of Florida's Conservation Lands

by

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Abstract

The ecosystem service value provided by conservation lands can be a useful tool as governments evaluate conservation priorities. Therefore, the Florida State Department of Environmental Protection requested a study building on a previously conducted one valuing some of the State's 270 conservation areas. A benefit transfer valuation was conducted on 20 representative lands. Results indicated the conservation lands provided more than $5,340 per acre in ecosystem services. Although, these do not include every conservation area in Florida their dispersion throughout the State suggest that the remaining 240 conservation areas may also provide a high level of ecosystem services to the citizens of Florida. Further study is recommended to value the remaining State's protected areas.

Contents

Introduction

In May of 2013 staff from the Florida Department of Environmental Protection (DEP) asked the authors of this project to estimate ecosystem service values provided by conservation areas held by the State. To accomplish this task the client requested that the authors closely replicate the work of a previous study by researchers with Defenders of Wildlife (DOW), which estimated values for 10 of Florida's 270 conservation areas. The DEP requested a new study to value ecosystem services provided by additional conservation areas.

To approach this task, the authors first familiarized themselves with the DOW study and its methods. The primary concern was the source of the per acre dollar values for the services provided by unique ecosystems within preserved areas and whether these values would still be applicable to an expansion of the study conducted nearly six years after the original study. The DOW study used a method known as benefit transfer to obtain an economic value for the services provided by the ecosystem in the preserved areas.

In this study, values derived from primary studies are assigned to different ecosystem types in additional tracts using the benefit transfer method. In order to measure the benefit of maintaining these areas as conservation lands rather than developed landscape, the alternative considered is the use of the selected tracts for construction, urbanization, agriculture or ecosystem under high intensity of human-influence. The objective of this study is to estimate the benefit of natural ecosystems in conservation areas in Florida.

Literature Review

Ecosystem Services

People have understood ecosystems' provision of benefits through services for thousands of years. Historically, these were understood as provisioning services such as shelter in forests or soil retention for increased agricultural production (Fisher, Turner et al. 2009). However, in the modern era as studies such as Westman's 1977 article "How Much are Nature's Services Worth?" began to call for the accounting and quantification of the services provided by nature's functions. Westman made the argument that society, in moving ever towards cost-benefit analyses in making policy decisions, needed a more accurate accounting of the entirety of services provided by nature in order to appropriately value the benefits humans obtain from nature (Westman 1977).

As this research area evolved, the research and dialogue shifted towards the methods for ascertaining the services economic value (Gómez-Baggethun, de Groot et al. 2010). In 1997, Costanza et. al published a seminal work attempting to quantify the values of all ecosystems worldwide. Costanza's paper, though immediately controversial, brought much publicity to the valuation of ecosystem services and is still widely cited today (Heal, Barbier et al. 2004).

With increasing attention on this new field, the United Nations commissioned scientists around the world to "…assess the consequences of ecosystem change for human well-being and to establish the scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being…The assessment focuse(d) on the linkages between ecosystems and human well-being and, in particular, on ecosystem services"(ME Assessment 2005). The resulting publication was the Millennium Ecosystem Assessment (MA). A collaboration of more than 1,300 scientists, the project found that with population growth there is evermore demand on the services provided by ecosystems while the quality of ecosystems worldwide has been degraded (ME Assessment 2005)

The MA provided the research and practice community with a definition of ecosystem services:

> *Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious, and other nonmaterial benefits (ME Assessment 2005).*

This is the definition that the authors of this report use when discussing ecosystem services. After the publication of the MA, the interest in the field of ecosystem services has exploded (Perrings 2006).

Valuation Methods

I. Categories of economic values

As noted above, ecosystem services provide a variety of benefits for human beings, including products that are directly utilized by people, and functions that benefit human beings through immediate products. Both of these direct and indirect uses bring economic value to human life. For example, the function of water purification supports better habitat for wildlife and more diverse vegetation. Meanwhile, the improvement in water quality decreases the water treatment cost, and raises thebenefits from freshwater fisheries and recreational visits. In this example, the fishery benefit is derived from direct use of the ecosystem, but the increase in aesthetic value is derived from indirect use or passive use of the ecosystem.

To obtain an unbiased estimation of the economic value of uses and functions, it is necessary to distinguish the type of values. The total economic value(TEV) provided by ecosystem could be divided into use value and passive use value (also known as non-use value)(Prato 1998). As depicted in Figure 1, use value refers to the benefit derived from the ecosystem service or products that are directly or indirectly related to human production of goods and services. Non-use value, unlike the value attached to any actual use, is tied to the motivation of individuals to qualify the ecosystem not based on their own use (Carson, Flores et al. 1999). It should be noted that in some studies, *bequest value* is classified as a component of *option value* (Pagiola, Von Ritter et al. 2004), but the classification in Figure 1 is widely accepted.

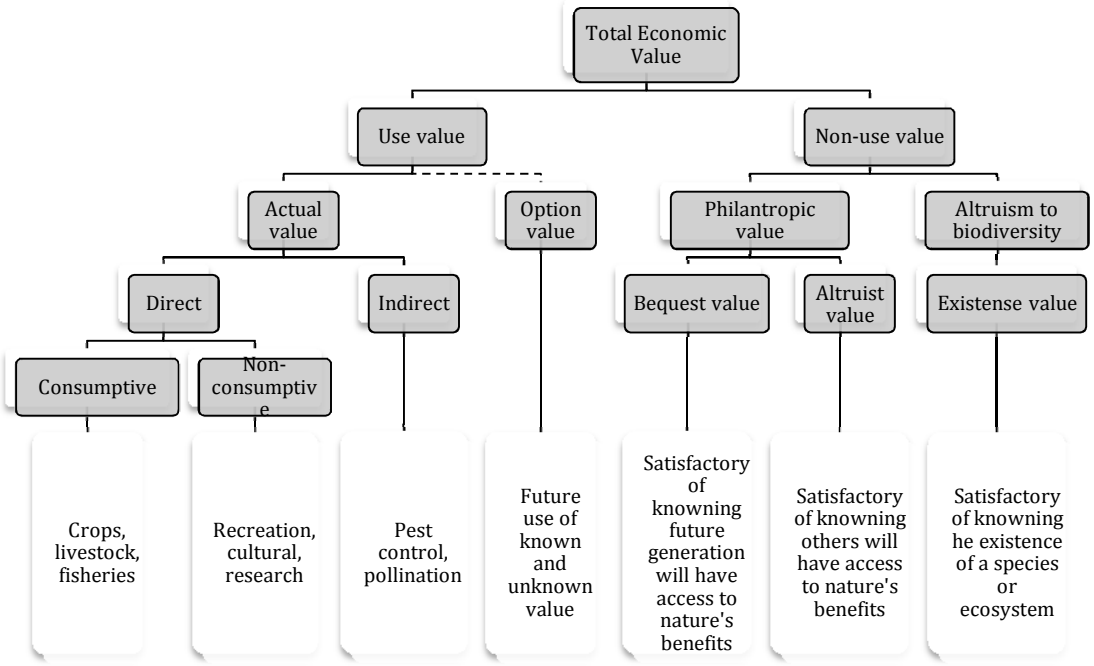

Figure 1. Components of the Total Economic Value of a natural resource (adapted from Kumar 2010)

Table 1 gives a closer look at the types and examples of TEV. Here, the indirect use value is the main concern of this study, i.e. the value derived from the indirect support and protection provided by ecosystem function, which is also known as the ecosystem functional value(Barbier 1993, Kroeger and Manalo 2006). For example, the clean water regulation function provided by wetlands reduces the water control cost for the downstream residents.

Table 1. Use Values and Benefits Provided by Ecosystems and Species

Value Category	Benefit	Example
Use values		
Direct use value[1]	Non-consumptive recreation	Wildlife/Scenery viewing
	Consumptive recreation	Hunting and Fishing
	Consumptive non-recreation uses	Wild foods, fibers, water, minerals for sustenance and sale
	Livestock production	
	Social, religious, and spiritual events	
	Education & Research	
	Nature-inspired art, crafts, and publications	Calendars, TV shows
	Real estate value premium in undeveloped/low density areas	
Indirect use values (ecosystem service values)	Pollination services Hydrological services Erosion prevention Carbon sequestration Biodiversity maintenance Habitat provision, etc.	
Option value	Possibility to engage in direct use of the resource in the future	Pharmaceutical products, conserved habitats
Non-use values		
Existence value	Value of knowing the continued existence	Habitat, endangered species
Stewardship value	Appreciation of the fact that this scenic beauty and the natural systems are actively managed	

Bequest value	Value that are passed on to future generations	Habitat, endangered species

[1]Market and non-market values.

Source: (Kroeger and Manalo 2006).

II. Approaches to valuation

There are a variety of approaches to transfer the ecosystem service into economic values, but not all of the methods are appropriate for a specific study. According to the value types depicted in Table 1, economists usually apply different valuation techniques to different values that need to be estimated. For example, to valuate the water purification that occurs in an urban area, the hedonic price of property nearby the river would be appropriate (Loomis, Kent et al. 2000). If the study primarily focuses on the value of greenhouse gas regulation by a forest, then averting behavior method could be applied to estimate the effect on human health. Table 2 summarizes the common valuation techniques in current studies, and provides the related applications and ecosystem types.

The concept of ecosystem valuation is to measure the economic impact of change in ecosystem service on the welfare or utility experienced by individuals. For example, if the degradation of habitat in a forest ecosystem will affect the air quality in surrounding areas, one would like to estimate the economic value of individual loss caused by the degradation. There are two approaches commonly used to estimate the ecosystem service value; willingness-to-pay (WTP), and willingness-to-accept (WTA). Research has found the individuals' WTP is in most cases significantly smaller than their WTA (Kroeger and Manalo 2006).

Table 2. Valuation approaches and applications

Type of Goods	Valuation Approach	Common Application	Ecosystem Services	Reference
Market goods	Market Prices	Food, Vegetation, Material	Pollination, Food Production, Water Supply	
	Avoidance costs	Coral reef protection, habitat protection	Water Regulation, Erosion control	(Miththapala 2008)
Non-market goods	Travel cost	Traveling, Recreational Hunting	Refugia, Recreation	(Knoche and Lupi 2007)
	Hedonic price	Residential property	Water regulation, gas regulation, Recreation, Waste treatment, etc.	(Leggett and Bockstael 2000)
	Production function	Recreational and commercial fishing, hydrological functions	Water regulation, biological control, nutrient cycling	(Johnston, Grigalunas et al. 2002)
	Stated Preference	Both use and nonuse value	Water regulation, biological control, refugia, cultural, etc.	(Costanza, d'Arge et al. 1997)

Source: adapted from (Heal, Barbier et al. 2004, Spangenberg and Settele 2010) Note: the ecosystem services classification followed the classification in Costanza's(Costanza, d'Arge et al. 1997) study.

Recreation value

Despite the importance of recreation in total economic value, this study does not account for recreational values. While a complete ecosystem valuation would include these values, it was concluded in consultation with OES to remain consistent with the DOW study and proceed without these values. Notwithstanding the exclusion of recreational values from this study, a sense of their importance to Florida's conservation lands is presented below.

As two of the major functions provided by state parks and state forests, recreational and cultural values generally provide a large portion of the total benefit value. Furthermore, recreation is often listed to be the major concern of managers and users. In a 2008 study of public land management agencies and users of the land, the most frequently selected ecosystem services of import were recreation and recreation-related (AbdElraman, Adams et al. 2012). According to the Florida Park Service data, the state parks in Florida, through direct expenditure, provided $1.11 billion to the Florida economy in fiscal year 2012 – 2013(Florida Park Service 2013).

Florida's Conservation Lands

Florida's Land Conservation Introduction

The state of Florida has an impressive history of purchasing and conserving land. This conservation success has come despite the direct competition for land from the breakneck speed at which Florida has developed. From 1950 to 2010 Florida's population grew from 2,771,305 to 18,801,310 residents(U.S. Census Bureau 2012). In recognition of this threat to Florida's unique ecosystems Florida politicians instituted the state's aggressive acquisition of conservation lands. As a result, in 1964 legislators began implementing a series of measures, such as issuing bonds or levying sales taxes, to fund purchases of conservation lands (Chapin and Coutts 2011).

By 1990, the state held nearly 200,000 acres of preserved land but politicians began fearing that the pace of acquisition was not occurring as rapidly as necessary; development was continuing unabated and the Governor's Commission on the Future of Florida's Environment "…warned, the state would lose three million acres of wetlands and forests by 2020" (Chapin and Coutts 2011). On the advice of the Commission, the state legislature instituted the Preservation 2000 program. Preservation 2000 was funded by a 17-cent increase in the documentary stamp tax and authorized 3 billion dollars in expenditures over the next 10 years on priority lands conservation. The popularity of the program could be seen in the legislature appropriating the full 300 million dollars each year. The program's esteem led to a reauthorization, with some minor changes, in 2000 for another 3 billion dollars over 10 years under the name Florida Forever (Chapin and Coutts 2011).

The success of these programs can be seen in the growth of lands the state manages for conservation purposes. Today, DEP Office of Environmental Services (OES) controls 270 conservation areas covering 3.3 million acre composed of

various ecosystems throughout the State (FNAI 2013). Despite the program's success and reauthorization, Florida Forever's longevity is not guaranteed.

As Florida's economy plummeted during the 2008 recession, the legislature could not agree to fund Florida Forever for fiscal year 2009. Florida Forever fared slightly better in 2010 when the legislature appropriated to the program a lifeline of $15 million dollars or 1/5 of the programs previous budgets (Chapin and Coutts 2011). In the 2012 budget, legislators passed a provision advising the state to sell excess conservation lands, in order to purchase $50 million dollars' worth of land that is listed on the state's remaining priority preservation list (Palmer 2013).

It was under these conditions that our client, OES, contacted the authors to provide an ecosystem service valuation of a representative sample of Florida's conservation areas. OES had received a study conducted in 2008 that provided values for 10 of Florida's conservation lands. This valuation appeared to be effective in informing officials and citizens alike of the value ecosystem services can provide. Recognizing the usefulness of analyzing ecosystem services through an economic lens, OES requested a new study providing a valuation of even more conservation lands.

Previous Study on Ecosystem Service Valuation

In 2008, recognizing that both environmental groups and the State had identified billions of dollars' worth of critical lands that had yet to be purchased, environmental groups pushed to extend Florida Forever and increase the annual allotment to $600 million annually (Chapin and Coutts 2011). In order to provide the public and policymakers with values of the services provided by conservation lands, DOW conducted a preliminary report on the use values of 10 of Florida's 270 lands(Casey, Frank et al. 2008).

Casey and co-authors selected 10 lands across the state of Florida, making up roughly 10% of the conserved land acreage, representative of the diverse ecosystems of the state. The tracts selected also included endemic and high priority ecosystems.

To evaluate the indirect use value provided by ecosystem services the study used a three-step process. First, the authors determined the acreage of each ecosystem within the selected areas. Contained within the tracts were 47 unique ecosystems as determined by the Florida Natural Areas Inventory (FNAI). Second, the ecosystems were aligned with the classifications derived by the aforementioned 1997 Costanza study. Finally, inflation adjusted numbers found in the Costanza study was applied to the Florida ecosystems. The preliminary results found that the nearly 400,000 acres provided a 2008 inflation adjusted value of $5,052 per acre or $1,823,963,206 (Casey, Frank et al. 2008).

Methods

Tract Selection

As mentioned previously, the DOW study provided a valuation of 10 areas from the 270 conservation areas managed by OES, leaving 260 areas from which to select the representative sample units for this study. OES was kind enough to provide a formatted Microsoft Excel document with all 270 tracts including name, size, and managing agency. Similar to the DOW study, the selection of 20 land tracts for this study was based on the dominant natural communities, locations, sizes, and endemic species representative of the entire portfolio of conservation lands in Florida.

First the spreadsheet was organized into the land tracts' corresponding five managing districts (Northwest, Northeast, Central, Southwest, and Southeast) as defined by the District Offices of the Florida Department of Environmental Protection (DEP) (2013)to make sure the selected tracts are evenly distributed across the state. Then research was conducted on the natural communities and endemic species found within each land tract. This data was compiled by Florida Natural Areas Inventory (FNAI) and found via each tract's website or management plan. Next land areas smaller than 1,000 acres were removed because most of these protect fewer natural communities than larger sized areas, or serve as complimentary areas for larger land conservation areas. Among the remaining 141 tracts larger than 1,000 acres, the dominant natural communities within each area were examined, and tracts with the least common dominant natural communities were selected. For example, John Pennekamp Coral Reef State Park was chosen because coral reefs and seagrass beds can only be found in this area. Land tracts were selected as such in order to cover as many ecosystem types as possible and to avoid ignorance and duplications. The final step to narrow the selection was to select tracts ensuring diversity of size and location. Therefore, 13 tracts were removed that contained relatively common natural communities, fewer endemic species, or shared similar size/location with other alternatives. In this step one tract larger than 200,000 acres and 6 tracts smaller than 10,000 acres were selected. This step eliminated all but 20 tracts distributed evenly across the state from the six districts (Table 3).

Geospatial Information

Assuming each acre within an ecosystem type provides the same ecosystem service, the benefit values in DOW's study were estimated by applying ecosystem service values from Costanza's (1997) study to the similar ecosystem types observed in Florida. Having a completed list of ecosystem types in the study areas is the first step to obtain values of ecosystem function for each of the ecosystem categories.

With the Cooperative Land Cover Map providing natural community types and the dataset of conservation area boundaries developed by FNAI obtained from FNAI's website, a map of ecosystem types (aggregated into 19 classes, detailed

explanation is in *Ecosystem Aggregation* section) layered with the study areas was created in *ArcGIS* (Figure 2); study tracts labeled with IDs are listed below (Table 3). A table showing the name and acres of the ecosystem types within each study area is given in Appendix A.

Table 3. Selected Conservation Areas

ID	Name	Acreage
0	Pumpkin Hill Creek Preserve State Park	3,967
1	Apalachicola River Wildlife and Environmental Area	63,257
2	St. Sebastian River Preserve State Park	21,362
3	Three Lakes Wildlife Management Area	63,487
4	Lake Kissimmee State Park	5,893
5	J. W. Corbett Wildlife Management Area	60,478
6	Kissimmee Prairie Preserve State Park	53,732
7	Salt Lake Wildlife Management Area	11,192
8	Jennings State Forest	24,033
9	Estero Bay Preserve State Park	11,382
10	John Pennekamp Coral Reef State Park	63,846
11	Waccasassa Bay Preserve State Park	34,166
12	John M. Bethea State Forest	37,735
13	Tomoka State Park	1,620
14	Dagny Johnson Key Largo Hammock Botanical State Park	2,482
15	Fakahatchee Strand Preserve State Park	77,574
16	Tiger Bay State Forest	27,396
17	St. Lucie Inlet Preserve State Park	4,835
18	Cayo Costa State Park	2,461
19	Blackwater River State Forest	210,423
Total Acreage		**781,321**

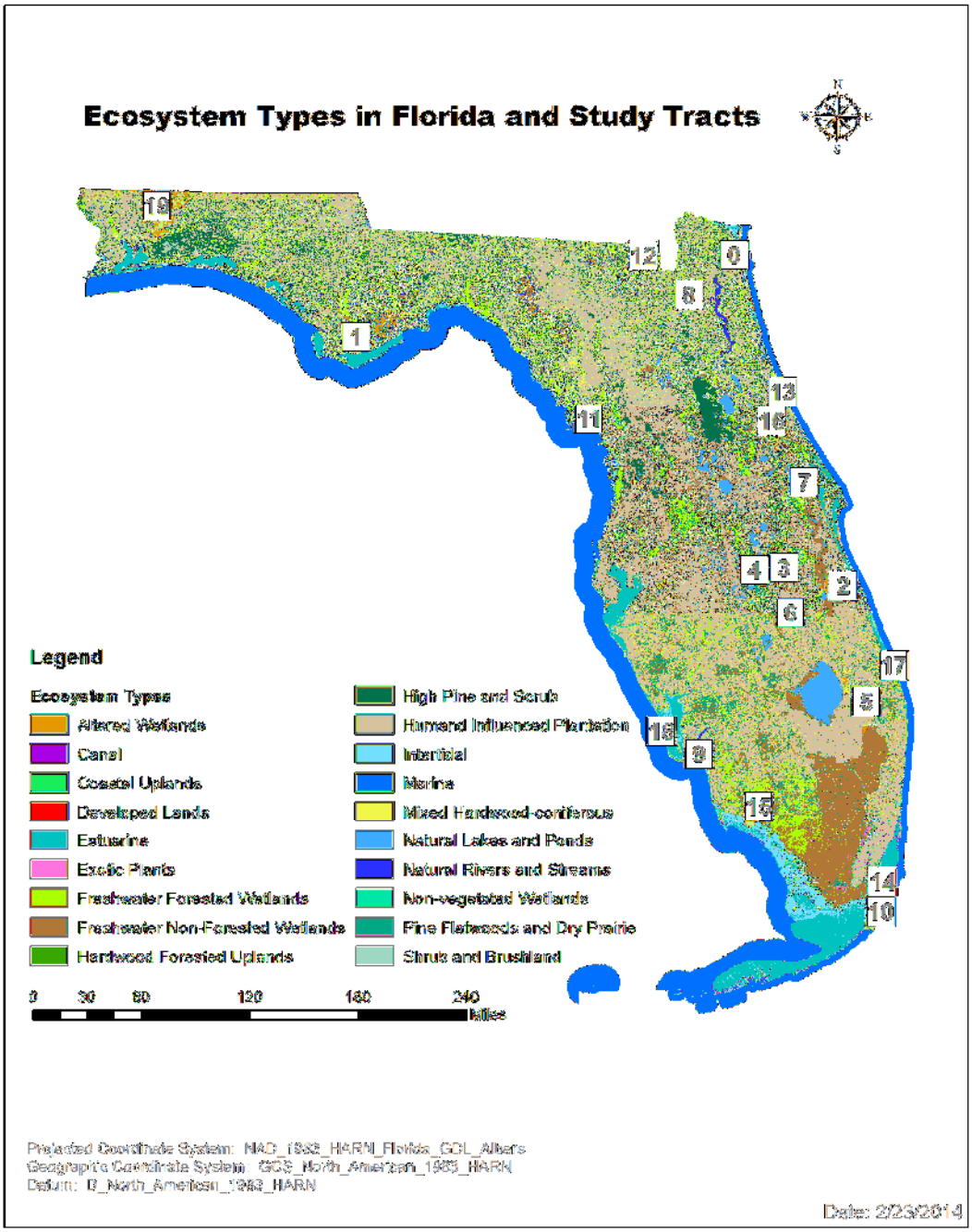

Figure 2. Ecosystem Types in Florida and Study Traces

Ecosystem Aggregation

Florida supports a variety of natural communities, and some of them are still preserved in high richness and diversity. According to the Land Cover Classification System Definitions provided by FNAI(Kawula 2012) updated in December 2012, there are 81 natural communities across the whole state. When estimating the ecosystem values by each ecosystem types, the result will obviously be more accurate if the values are community sensitive. However, without the support from

high-resolution fieldwork, it is hard to apply different values to natural communities. In DOW's study, the natural communities have been aggregated into 9 ecosystem types to be aligned with Costanza's (Costanza, d'Arge et al. 1997) study. Since this study uses primary results of other studies conducted in a variety of areas, it is arbitrary to align the ecosystem types in Florida to any of the classifications used by other studies. In order to maintain the uniqueness and diversity of ecosystem types as much as possible, the authors have followed the classification system defined by FNAI.

As the first step, developed and constructed land cover was eliminated from our research area (Table 4). This is done so because the study is focused on the natural ecosystem benefit, and human influence will largely change the ecosystem service. The elimination left out 54 natural communities for further aggregation. The next step was to combine the natural communities by their class codes into the 2-digit code level given in the Land Cover Classification System Definitions (Kawula 2012). For example, all community classes with prefix code of "11", including "111 Upland Hardwood Forest", "1112 Mixed Hardwoods", "112 Mesic Hammock", "1131 Thorn Scrub", and etc., have been combined to the ecosystem type "11 Hardwood Forested Uplands"(Appendix B). In total 19 ecosystem types are present in Florida after combining (Figure 2). To ensure the homogeneity within each ecosystem types, "Scrub and High pine" is separated into "Scrub" and "High pine", and is remerged into "Scrub and Dry Prairie" and "Pine flatwoods" accordingly. The further step is to eliminate the ecosystem types smaller than 1,000 acres to exclude the "fragmented" ecosystem types, including Non-vegetated wetland, Altered wetland and Exotic plants. This step leaves 13 aggregated ecosystem types.

Table 4. Eliminated Ecosystem Types

Ecosystem Type	Acre	Ecosystem Type	Acre
Cemeteries	1.85	Row Crops	38.52
Community rec. facilities	9.76	Sod Farms	3.85
Golf courses	2.10	Specialty Farms	10.27
Low Intensity Urban	1.53	Tree Nurseries	0.00
Low Structure Density	82.28	Rails	14.80
Parks	109.40	Roads	428.13
Urban Open Land	1.19	Transportation	266.89
Commercial & Services	40.19	Communication	16.75
High Intensity Urban	168.49	Utilities	2087.19
Industrial	0.08	Extractive	18.46
Institutional	73.95	Oil & Gas Fields	6.16
Residential, High Density	2.92	Sand & Gravel Pits	70.48
Residential, Med. Density	27.43	Spoil Area	83.28
Agriculture	1330.12	Strip Mines	14.34
Citrus	0.07	Aquacultural Ponds	46.02
Fallow Cropland	7.11	Impoundment/Reservoir	250.20

Feeding Operations	0.05	Artificial Lakes and Ponds	181.71
Field Crops	309.74	Quarry Pond	65.19
Orchards/Groves	0.10		
Total			**5770.64**

Note: The names of ecosystem types are shown in Site level names, which are the sub-class type of natural communities given by FNAI.

Table 5. Aggregated Ecosystem Types

Class Code	Ecosystem Type	Total Acres	Percentage
11	Hardwood Forested Uplands	10,077.52	1.31%
12,13,15	Scrub and Dry Prairie	71,091.26	9.28%
12,13	Pine Flatwoods and Pine Uplands	181,699.16	23.71%
14	Mixed Hardwood-coniferous	1,325.98	0.17%
16	Coastal Uplands	2,016.59	0.26%
18	Human Influenced Plantation	89,460.07	11.67%
21	Freshwater Non-Forested Wetlands	82,145.39	10.72%
22	Freshwater Forested Wetlands	199,778.24	26.07%
31	Natural Lakes and Ponds	2,097.83	0.27%
41	Natural Rivers and Streams	3,617.59	0.47%
50	Estuarine	35,434.27	4.62%
52	Mangrove	21,804.24	2.85%
60	Marine	63,682.14	8.31%
Total			**764,230.27**

Assigning Values

Benefits transfer is the method applied in this study to assign values to the ecosystems found in the study regions. This method, "…uses results from pre-existing primary research to predict welfare estimates for other sites of policy significance for which primary valuation estimates are unavailable" (Johnston and Rosenberger 2010, p. 479). Although, it would be better to ascertain values through primary research, it is often impossible due to the financial or time constraints of a given project. The two commonly accepted methods of benefit transfer in environmental economic field are: 1) value transfer and 2) function transfer (Rosenberger and Loomis 2003).

Value transfer is a method of applying a single measure from primary research conducted at a similar site to a given study site. The assumption required for a value transfer is that the welfare on an individual at the study site is equivalent as the benefit experienced at a given policy site. If this assumption is made then the benefit from the study site can simply be applied to the policy site (Navrud 2010). This can also be done by finding multiple study sites similar to the policy site and applying a measure of central tendency, such as a mean or median, to the policy site (Rosenberger and Loomis 2003)

Function transfers are a more complex type of benefit transfer. In this method statistical regression output from a study site including ecosystem function and population characteristics are compared against the policy site. After a relationship between the functions has been determined, a value for the policy site can be applied (Rosenberger and Loomis 2003). An even more involved manner of conducting a function transfer is via a meta-analysis regression analysis. In a meta-analysis, the values found in multiple studies are regressed on features such as the characteristics of sites, value type, and study methodology (Rosenberger and Loomis 2003)

It is understood that function transfers are a better estimator of actual ecosystem service value than benefit transfers. However, a 2008 study compared the value transfer method against the two function transfer methods. Surprisingly, simple value transfers were better at predicting the actual value of ecosystem services than either function transfers (Lindhjem and Navrud 2008). However, the authors noted that care must be taken in selecting study sites from which to assign values on policy sites as there is much room for large transfer error.

The DOW study used the value transfer method in assigning values. Values used by DOW were pulled from the 1997 Robert Costanza paper assigning values to the entire globe (Casey, Frank et al. 2008). As mentioned, the Costanza study is a controversial one. The paper elicited concerns due to the assumptions the paper relied upon as well as the economic results presented. Costanza estimated that the value of the world's ecosystems in 1997 was $33 trillion (Costanza, d'Arge et al. 1997). Economists have noted that if this is a willingness to pay figure then it must be bounded by world gross domestic product, at the time $18 trillion. If the number is a willingness to accept figure then $33 trillion is low considering it is estimating value for the life support of the entire planet (Daily 2004). , There are several criticisms of the study's assumptions, but the most pertinent problem is the aforementioned room for large transfer errors of benefit transfers and the subsequent need to find study areas similar to the policy sites. Therefore, when values are estimated for ecosystems at a scale the size of the entire biosphere, the values are imprecise when they are then imposed on a much smaller scale like acres in Florida(Daily 2004).

In light of these concerns, a discussion was had with the authors of the DOW study in order to gauge their thoughts on applying the Costanza values to an updated study. In the course of the call it became clear that the previous study authors felt that a more appropriate and accurate method would be the use of a value transfer from primary studies conducted at ecosystems comparable to the ones found in the selected tracts. A decision was made to proceed following as closely as possible to the best practices in benefit transfer as outlined by Navrud (p.7-p.8):

1) Identify the change in the environmental good to be valued at a policy site
2) Identify the affected population
3) Conduct a literature review to identify relevant primary studies

4) Assess the relevance/similarity and quality of study site values for transfer
5) Select and summarize the data available from the study sites
6) Transfer value estimate from study sites to policy site
7) Calculate total benefits or costs
8) Assess uncertainty and transfer error (Navrud 2010)

Results

Following the benefit transfer criteria, values derived from eight studies were applied to the ecosystem types in Florida. As the methods used to estimate the ecosystem values varied across the eight studies, benefit values were carefully transferred into per acre values (Table 6). Among the ecosystem types, Intertidal provides the highest value. The main natural community within intertidal ecosystem is mangrove, which is observed to play an irreplaceable role in carbon sequestration. The Marine ecosystem exhibits the lowest per acre value across the 17 ecosystems.

Table 6. Annual Value of Aggregated Ecosystem Types (in 2013 dollars)

Ecosystem Types	$/Acre	Reference
Hardwood Forested Uplands	5,374	(AbdElraman, Adams et al. 2012)
Scrub and Dry Prairie	128	(AbdElraman, Adams et al. 2012)
Pine Flatwoods	5,374	(AbdElraman, Adams et al. 2012)
Mixed Hardwood-coniferous	5,374	(AbdElraman, Adams et al. 2012)
Coastal Uplands	900	(Petrolia and Kim 2009)
Human Influenced Plantation	5,374	(AbdElraman, Adams et al. 2012)
Non-Forested Wetlands	4,289	(Yoskowitz, Carollo et al. 2012)
Freshwater Forested Wetlands	8,256	(AbdElraman, Adams et al. 2012, Yoskowitz, Carollo et al. 2012)
Natural Lakes and Ponds	3,674	(Takatsuka 2004)
Natural Rivers and Streams	3,674	(Takatsuka 2004)
Estuarine	1,635	(Johnston and Rosenberger 2010)
Mangrove	17,426	(Jerath 2012)
Marine	1,664	(Bishop, Chapman et al. 2011)

Note: Appendix C gives the detailed information on the methods being used in these studies.

* The values of ecosystem types with less than 1,000 acres are not estimated because the service provided by smaller ecosystems are usually related with larger ecosystem types; isolating the ecosystem value of small area from large scale is difficult.

Values were assigned to the corresponding ecosystem type within each conservation area. Table 7 presents the value of aggregated ecosystem types in

conservation areas and the combined total value of each tract. The Blackwater River State Forest contributes most to the total ecosystem value due to the large area of High Pine and Scrub. The total value provided by each ecosystem is displayed in Table 8.

Table 7. Aggregated Ecosystem Value of Each Study Tract (1,000$/yr, in 2013 dollar)

Ecosystem Type/Conservation Areas	Apalachicola River Wildlife and Environmental Area	Blackwater River State Forest	Cayo Costa State Park	Dagny Johnson Key Largo Hammock Botanical State Park	Estero Bay Preserve State Park	Fakahatchee Strand Preserve State Park	J. W. Corbett Wildlife Management Area	Jennings State Forest	John M. Bethea State Forest	John Pennekamp Coral Reef State Park
Hardwood Forested Uplands	1,248	4,829	-	6,635	23	1,176	1,667	1,774	-	2,538
Scrub and Dry Prairie	720	2,050	-	3	7	3	-	836	33	2
Pine Flatwoods and Pine uplands	7,012	631,228	-	146	2,359	778	90,488	36,578	781	-
Mixed Hardwood-Coniferous	128	3,829	-	-	32	-	-	1,009	103	-
Coastal Uplands	-	-	1,602	33	-	-	-	-	-	3
Plantation	42,004	172,856	0	102	31	48	3,798	11,831	96,796	0
Freshwater Non-Forested Wetlands	1,705	27,917	156	-	1,324	80,453	73,074	530	9,938	-
Forested Wetland	360,686	249,147	-	390	2,031	373,703	190,916	62,976	139,952	-
Natural Lakes and Ponds	-	4	-	-	17	180	-	-	-	-
Natural Rivers and Streams	9,443	2,731	-	-	142	424	-	123	-	23
Estuarine	2,051	-	42	347	3,581	5,792	-	-	-	420
Mangrove Swamp	-	-	10,246	15,831	131,980	154,546	-	-	-	55,617
Marine	-	-	6	216	-	-	-	-	-	99,523
Total	**424,997**	**1,094,590**	**12,053**	**23,703**	**141,529**	**617,103**	**359,944**	**115,657**	**247,603**	**158,126**

Ecosystem Type/Conservation Areas	Kissimmee Prairie Preserve State Park	Lake Kissimmee State Park	Pumpkin Hill Creek Preserve State Park	Salt Lake Wildlife Management Area	St. Lucie Inlet Preserve State Park	St. Sebastian River Preserve State Park	Three Lakes Wildlife Management Area	Tiger Bay State Forest	Tomoka State Park	Waccasassa Bay Preserve State Park
Hardwood Forested Uplands	4,421	2,232	17	1,067	-	214	24,345	-	1,966	-
Scrub and Dry Prairie	3,112	-	16	8	-	105	1,989	215	14	-
Pine Flatwoods and Pine uplands	1,438	6,597	14,247	5,144	-	67,240	101,331	9,476	827	732
Mixed Hardwood-Coniferous	2	-	255	19	40	699	184	558	265	-
Coastal Uplands	-	-	1	-	152	-	-	-	23	-
Plantation	67,408	4,402	172	35	476	11,309	23,882	45,419	-	167
Freshwater Non-Forested Wetlands	65,111	8,988	96	10,230	-	15,548	40,375	16,777	41	54
Forested Wetland	4,954	9,641	9,604	4,613	-	12,202	75,390	91,634	1,517	60,075
Natural Lakes and Ponds	0	-	18	3,070	-	-	4,034	384	-	-
Natural Rivers and Streams	36	280	9	-	-	26	0	-	16	36
Estuarine	-	-	37	-	296	2	-	-	1,075	44,279
Mangrove Swamp	-	-	-	-	11,227	-	-	-	13	501
Marine	-	-	-	-	6,105	-	-	-	-	117
Total	**146,483**	**32,140**	**24,472**	**24,186**	**18,296**	**107,343**	**271,530**	**164,464**	**5,758**	**105,961**

Table 8. Annual Total Value of Study Tracts ($/acre, in 2013 dollars)

Name	Acres	Value/Acre
Apalachicola River Wildlife and Environmental Area	63,257	6,719
Blackwater River State Forest	210,423	5,202
Cayo Costa State Park	2,461	4,898
Dagny Johnson Key Largo Hammock Botanical State Park	2,482	9,550
Estero Bay Preserve State Park	11,382	12,434
Fakahatchee Strand Preserve State Park	77,574	7,955
J. W. Corbett Wildlife Management Area	60,478	5,952
Jennings State Forest	24,033	4,812
John M. Bethea State Forest	37,735	6,562
John Pennekamp Coral Reef State Park	63,846	2,477
Kissimmee Prairie Preserve State Park	53,732	2,726
Lake Kissimmee State Park	5,893	5,454
Pumpkin Hill Creek Preserve State Park	3,967	6,169
Salt Lake Wildlife Management Area	11,192	2,161
St. Lucie Inlet Preserve State Park	4,835	3,784
St. Sebastian River Preserve State Park	21,362	5,025
Three Lakes Wildlife Management Area	63,487	4,277
Tiger Bay State Forest	27,396	6,003
Tomoka State Park	1,620	3,555
Waccasassa Bay Preserve State Park	34,166	3,101

Limitations

Due to the differences in value transfer methodology, it is likely that the values presented in this study are a more accurate representation of ecosystem service benefits than the previous DOW study. Following established benefit transfer value methods provided values for ecosystems found within these parks. As always, a primary valuation study would lead to a more accurate value of ecosystem services, however, such studies are quite expensive.

It is then helpful to estimate errors in benefit transfer methods. In his 2010 paper Navrud suggested a checklist to determine estimated error by benefit transfer studies (Navrud 2010). These estimates are determined by analyzing the soundness of the original study, relevance to the policy site, and the richness in detail provide by the study. Depending on the level of conformance to Navrud's standards the level of transfer error can be estimated (Table 9).

Table 9. Navrud's Criteria For Evaluating Goodness of Fit

Category	Level of Fit Between Primary Site and Policy Site	Percentage Transfer Error (+/-)
1	Very Good Fit	± 20
2	Good Fit	± 50
3	Poor Fit	± 100
4	Very Poor Fit	Meta-Analysis is the Only Option

Source: (Navrud 2010)

Applying Navrud's criteria, with the acknowledgment that our primary research sites did not, in every circumstance, fall within the very good fit level, we conclude that the value of services provided by these conservation lands is high. At the 50% transfer error these areas would still provide over $2 billion dollars of value a year to Florida's citizens of more than $2,600 dollars/acre.

Conclusion and Discussion

The results of total ecosystem value of $4,095,944,728 for the 20 tracts examined in this study or $5,340/acre, compare favorably to the results of $5,052.00/ acre found of the land studied by DOW. The results presented here point to the value provided to Florida residents by services (water quality, greenhouse gas sequestration, nutrient retention, etc.) from conserved natural areas. As Florida's population is expected to increase by roughly 35% to 25.5 million residents by 2040 these services will become increasingly demanded (University of Florida 2013). As a result, it is important for policymakers to take into account the entirety of the services provided by Florida's ecosystems.

This study reinforces that Florida's conservation lands provide great value to the citizens of the state. At slightly under 25% of Florida's conservation lands, this study does not value the entire state's lands. However, the selection of tracts containing heterogeneous ecosystem types dispersed throughout the state adds confidence to the assumption that conservation lands that are yet to be studied also provide significant value via ecosystem services.

Further benefit transfer studies may be able to replicate our methods to provide estimates of even more of Florida's 270 conservation lands. However, it would be ideal if some primary research studies were to be conducted on areas within Florida that are unique to the state. Florida is a state with many unique habitats that are difficult to compare with other states or countries. While there appear to be many excellent studies being conducted on Florida ecosystem functions, few of these studies of function incorporate an analysis of the economic value of service provided by the function. Furthermore, these areas provide

excellent recreational and direct use benefits that are not quantified in this study. To obtain a more accurate representation of the economic benefits provided by Florida's lands, studies of recreational values should also be conducted.

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Appendix A

Ecosystems and Plant and Animal Species Found in Each Conservation Area

Apalachicola River Wildlife and Environmental Area

The 63,257 acres WEA in Franklin and Gulf Counties was purchased in 1974 under the Environmentally Endangered Lands Program. They were acquired to protect and preserve the highly productive Apalachicola River and Bay estuarine system. The bay area provides over 90 percent of Florida's oysters and is a major nursery for blue crabs and marine finfish. The dominant ecosystem types are floodplain forest, inter-tidal marshes, cypress swamps, pine flatwoods, wet savannas, wetland scrub shrub, maritime hammocks, mixed pine-hardwoods, and ruderal areas.

There are sixteen protected wildlife species and nineteen protected plant species within the Apalachicola River WEA. Endangered species include the Florida manatee, red-cockaded woodpecker, wood stork, Gray bat, and Indiana bat. Threatened species and Species of Special Concern include the gopher tortoise, alligator snapping turtle, Barbour's map turtle, American alligator, eastern indigo snake, Florida pine snake, bald eagle, little blue heron, snowy egret, white ibis, and Atlantic sturgeon(Florida Fish and Wildlife Conservation Commission 2002).

Blackwater River State Forest

The Blackwater River State Forest in Santa Rosa and Okaloosa counties was originally purchased in 1954 and added to through the Preservation-2000 and Florida Forever's Programs to the 210,423 acres it is today. The land was acquired to protect threatened and endangered species. The Blackwater River SF is the largest contiguous longleaf pine ecosystem left in the world, an ecosystem that used to be 90 million acres across the southeast to roughly 4 million currently. Blackwater's major ecosystems include upland pine, bottomland forest, floodplain swamp, sandhill, and seepage slope.

Blackwater contains 27 listed species and 30 listed plant species. Endangered species include the reticulated flatwoods salamander, and red-cockaded woodpecker. Threatened species and Species of Special Concern include the Florida bog frog, gopher frog, pine barrens treefrog, alligator snapping turtle, eastern indigo snake, gopher tortoise, little blue heron, roseate spoonbill, snowy egret, eastern chipmunk, and Sherman's fox squirrel(Florida Forest Services 2013).

Cayo Costa State Park

Cayo Costa in Lee County was purchased in 1976 under the Environmentally Endangered Lands Program and expanded under Preservation 2000 and Florida Forever. The park consists of portions of four islands covering 2,461 acres. The park contains eleven communities: Beach Dune, Coastal Berm, Coastal Strand,

Maritime Hammock, Mesic Flatwoods, Coastal Grassland, Shell Mound, Depression Marsh, Marine Tidal Marsh, Marine Tidal Swamp, Marine Unconsolidated Substrate, and Ruderal.

The park contains 35 listed species and 14 listed plant species. Endangered species include the Atlantic ridley, Atlantic green turtle, wood stork, snail kite, red-cockaded woodpecker, and bachman's sparrow. Listed and threatened species include: (Florida DEP 2005)

American alligator
gopher tortoise
Atlantic loggerhead
eastern indigo snake
eastern diamondback rattlesnake
eastern brown pelican
little blue heron
reddish egret
tricolored heron
black-crowned night heron
white ibis
roseate spoonbill
southern bald eagle,
crested caracara
peregrine falcon
southeastern American kestrel
Florida sandhill crane
Limpkin
American oystercatcher
least tern
black skimmer
piping plover
Wilsons' plover
southeastern snowy plover
white crowned pigeon
Florida burrowing owl
Florida scrub-jay
Sherman's fox squirrel
Florida black bear

Dagny Johnson Key Largo Hammock Botanical State Park

The Dagny Johnson Key Largo Hammock Botanical State Park in Monroe County was purchased in 1982 funded by the Land Acquisition Trust Fund. It is 2,482 acres and has the largest West Indian hardwood hammock in the continental United States. The park contains six natural communities Coastal Berm, Coastal Rock Barren, Pine Rockland, Rockland Hammock, Marine Tidal Swamp, and Ruderal.

Dagny Johnson contains 13 listed species and 49 listed plant species. Threatened and species of special concern include: the Eastern indigo snake, striped mud turtle, white crowned pigeon, America kestrel, southern bald eagle, least tern, and the roseate tern. Endangered species include the American crocodile, wood stork, Key Largo woodrat, and the Key Largo cotton mouse(Florida Fish and Wildlife Conservation Commission 2003).

Estero Bay Preserve State Park

The Estero Bay Preserve State Park in Lee County was originally acquired through a donation from the Nature Conservancy and later acquired through both CARL and Florida Forever Funds. Today the Park is 11,382 acres has been purchased to buffer the Estero Bay Aquatic Preserve and contains rare communities

such as cabbage palm hammock and coastal scrub. The major natural communities are Wet Flatwoods, Tidal Marsh, and Estuarine Tidal Swamp.

Estero Bay contains 16 listed species and 19 listed plant species. Threatened and species of special concern include: the Gulf sturgeon, Roseate spoonbill, American alligator, loggerhead turtle, common snook, Eastern indigo snake, little blue heron, reddish egret, snowy egret, tri-colored heron, white ibis, southeastern American kestrel, gopher tortoise, American oystercatcher, bald eagle, brown pelican, black skimmer, least tern and Florida black bear. Endangered species include the Atlantic green turtle, leatherback, hawksbill turtle, peregrine falcon, Kemp's ridley turtle, wood stork, snail kite and the Manatee (Department of Environmental Protection 2004).

Fakahatchee Strand Preserve State Park

The Fakahatchee Strand Preserve State Park was acquired as a state park in 1974 using Environmentally Endangered Lands program and later CARL funding. Prior to its use as a park Fakahatchee was intensively logged but was acquired due to its unique species and habitat. The major natural communities are Strand Swamp, Marl Prairie, and Estuarine Tidal Swamp.

Fakahatchee Strand contains 70 designated plant species and 26 animal species. It has the largest diversity of orchid species in North America. Endangered species include: the Florida Panther, West Indian Manatee, Florida 'bonneted' bat, American crocodile, Wood stork, and the Everglades snail kite(Florida Park Service 2011).

J.W. Corbett Wildlife Management Area

J.W. Corbett was acquired in 1947 as gameland and added to in 1993 with CARL funds. There are four natural communities within Corbett: Pine Flatwoods, Cypress Sloughs and Domes, Marshes and Prairies, and Hammocks.

The WMA contains 13 designated animal species. Threatened and Species of Special Concern include: the Sandhill crane, southeastern kestrel, caracara, bald eagle, least tern, Florida black bear, Everglades kink, and the Eastern indigo snake. Endangered species include: the Red-Cockaded woodpecker, Florida panther, snail kite, and the peregrine falcon (Florida Fish and Wildlife Conservation Commission 2003).

Jennings State Forest

Jennings State Forest in Clay and Duval Counties was purchased using CARL and Preservation 2000 funds in order to protect the watershed of the Upper Black Creek. The Forest has 16 natural communities but is dominated by Sandhills, Mesic Flatwoods, Baygalls, Bottomland Forests, and Wet Flatwoods.

Jennings contains 1 designated animal species and 12 designated plant species. The Species of special Concern is the gopher tortoise(Florida Department of Agriculture and Consumer Affairs 2007).

John M. Bethea State Forest

The John M. Bethea State Forest in Baker County was acquired in 2001 with CARL funds to protect irreplaceable flora and fauna, restore important ecosystems such as significant groundwater resources, and provide recreation. The Forest contains 5 natural communities: Mesic Flatwoods, Basin Swamp, Dome Swamp, Wet Flatwoods, and Bottomland Forest.

The Forest contains 9 designated animal species. Threatened or Species of Special Concern include: the Carpenter frog, many-lined salamander, Great Egret, little blue heron, Mud sunfish, blackbanded sunfish, Eastern mudminnow, Florida black bear, and the timber rattlesnake(Florida Department of Agriculture and Consumer Services 2004).

John Pennekamp Coral Reef State Park

John Pennekamp Coral Reef State Park was dedicated to the Division of Parks and Recreation and Parks in 1959 and later added to with state funds including the Preservation 2000 program. The Park was established to maintain the property for recreation and conservation. The property contains 10 natural communities. The major communities are Marine Grassland Bed and Marine Consolidated Substrate.

John Pennekamp contains 26 designated plant species and 22 animal species. Threatened and Species of Special Concern include: the Atlantic loggerhead turtle, roseate Spoonbill, little blue heron, reddish egret, snowy egret, tricolored heron, white ibis, American oystercatcher, osprey, brown pelican, back skimmer, and the least tern. Endangered species include: the Atlantic green turtle, leatherback turtle, American crocodile, Hawksbill sea turtle, Kemp's ridley turtle, wood stork, and the West Indian manatee(Florida DEP 2004).

Kissimmee Prairie Preserve State Park

The Kissimmee Prairie Preserve State Park in Okeechobee County was purchased in 1996 under the Conservation and Recreational Lands Program and Save Our Rivers Program. Currently the preserve contains approximately 53,760 acres, and 14 distinct natural communities. The major natural communities include Dry prairie, Wet prairie, Floodplain marsh, Depression marsh, Basin marsh, Swale, Slough, and Scrubby flatwoods.

The park contains 13 listed plants and 42 listed animals. Listed plants include bearded grass-pink (Calopogon barbatus), spreading pinweed (Lechea divaricata), hooded pitcher plant (Sarracenia minor), giant orchid (Pteroglossapsis ecristata), and twinberry (Myrcianthes fragrans var. simpsonii). Threatened or endangered species are Eastern indigo snake, Wood Stork, Snail Kite, Bald Eagle,

Crested Caracara, Florida Sandhill Crane, Florida Scrub-Jay, Florida Grasshopper Sparrow, and Florida panther(Florida DEP 2005).

Lake Kissimmee State Park

The Lake Kissimmee State Park is located in Polk County. The park was purchased in 1970 funded by the General Obligation Bonds(1968), and was conveyed to the Department of Environmental Protection under Lease No.2461. The park contains 12 natural communities including Floodplain marsh, Wet flatwoods, Mesic Flatwoods, Scrubby flatwoods and Upland Mixed Forest.

Lake Kissimmee contains 11 listed plants and 33 listed animals. Threatened or endangered species include Garberia, Catesby's lily, Cutthroatgrass, Yellow butterwort, Giant Orchid, Tooth lattice-vein fern, Cardinal airplant, Atamasco lily. Listed animal species include Bluetail mole skink, Eastern indigo snake, Wood Stork, Bald Eagle, Snail Kite, Crested Caracara, Southeastern American Kestrel, Florida Sandhill Crane, and Florida Scrub-Jay(Florida DEP 2004).

Pumpkin Hill Creek Preserve State Park

The pumpkin Hill Creek Preserve State Park in Duval County was purchased in 1994 to be managed as a state buffer preserve with the Florida Department of Environmental Protection. In 2003, the preserve is conveyed to Division of Recreation and Parks to be managed as a state park. The park contains 21 natural communities, which includes mainly Mesic flatwoods, Wet flatwoods, Scrubby flatwoods, Floodplain swamp, Sandhill, and Basin swamp.

The park contains 6 designated plant species including Pond spice, Cinnamon fern, Blue butterwort, Rosebud orchid, Hooded pitcherplant, and Sweet pinxter azalea. Fifteen listed animal species made their home in this park; species that are threatened or endangered are Eastern indigo snake, Peregrine Falcon, Bald Eagle, Wood Stork, and Least Tern(Florida DEP 2006).

Salt Lake Wildlife Management Area

The Salt Lake Wildlife Management Area in Brevard County was partially purchased in 1982 by St. Johns River Water Management District (SJRWMD). Other significant parcels of this area were purchased under the Preservation 2000 Program and the Brevard Coastal Scrub Ecosystem Florida Forever Project beginning in 1999. The WMA currently has 5,045 acres, and contains 10 distinct natural communities including Freshwater Marsh, Wet Prairie, Pinelands, Open Water, Mixed Wetland Forest, Mixed Pine-Hardwood Forest, Hardwood Swamp, and Shrub Swamp.

The WMA supports habitat for 14 wildlife species that are listed as Endangered, Threatened, or a Species of Special Concern including Bald eagle, Crested caracara, Florida sandhill crane, Florida scrub-jay, Limpkin, Little blue heron, Reddish egret, Roseate spoonbill, Snowy egret, Tricolored heron, White ibis,

Wood stork, American alligator, Eastern indigo snake, and Gopher tortoise(Florida Fish and Wildlife Conservation Commission 2006).

St. Lucie Inlet Preserve State Park

The St. Lucie Inlet Preserve State Park in Martin County was originally owned by the Trustees of the Internal Improvement Trust Fund in 1965. The purchase started in 1969 under the Land Acquisition Trust program. Currently the park has 4,786.46 acres and 10 different natural communities including Marine unconsolidated substrate, Marine worm reef, Estuarine tidal swamp, Estuarine grass bed, and Marine consolidated substrate mainly.

Listed species in the park include 8 species of plants and 29 species of animals. Threatened and endangered animals are Atlantic loggerhead turtle, Bald eagle, Least tern, West Indian manatee, Atlantic green turtle, Leatherback turtle, and wood stork. The eight listed species of plants in the preserve are Beachstar, Satinleaf, Common wild pine, Giant wild pine, Johnson's seagrass, Simpson's ironwood, Inkberry, and Reflexed wild pine(Florida DEP 2002).

St. Sebastian River Preserve State Park

Located in Brevard and Indian River counties, the St. Sebastian River Preserve State Park currently has 21,748.42 acres. The park was initially acquired by the Trustees of the Internal Improvement Trust Fund of the State of Florida and St. Johns River Water Management District in 1995 for approximately 6,894 acre. Subsequently, the Trustees and purchased 7,058 acres as part of the park under CARL/P2000 program in 1996. The major natural communities include Mesic flatwoods, Wet prairie, Scrubby flatwoods, Depression marsh, Hydric hammock, Strand swamp, Basin march, Baygall, Sandhill, Scrub, and Dome.

The state park contains 74 designated species including 28 plants and 46 animals. Species recovery plans are developed for many of the designated species including the Florida manatee, crested caracara, bald eagle, Florida scrub-jay, snail kite, wood stork, and the eastern indigo snake(Florida DEP 2005).

Three Lakes Wildlife Management Area

The Three Lakes Wildlife Management Area in Osceola County was acquired by DEP, Division of State Lands under the Environmentally Endangered Lands Program(EEL) in 1974. The Fish and Wildlife Conservation Commission purchased addition portion with funds of Preservation 2000(P2000) and Additions funding. The WMA contains 59,745 acres and covers at least 8 distinct natural communities. The dominant natural communities include Dry prairie, Prairie hammock, Wet prairie, Basin and depression marshes, Basin and strand swamp.

There are 17 listed animal species in the WMA. The threatened and endangered species and species of special concern include Florida gopher frog, American alligator, Easter indigo snake, Gopher tortoise, Florida grasshopper sparrow, Limpskin, Burrowing owl, Little blue heron, Snowy egret, Tricolored heron,

Whooping crane, Sandhill crane, Bald eagle, Wood stork, Red-cockaded woodpecker, Crested caracara, Sherman's fox squirrel(Florida Fish and Wildlife Conservation Commission 2001).

Tiger Bay State Forest

The Tiger Bay State Forest in Volusia County was initially acquired under the EEL program in 1979. Currently, the state forest was jointly acquired under the EEL, P2000, Florida Forever, and the Save Our Rivers Program with a complex of 27,396 acres. There are 12 distinct natural communities in the state forest. The dominant communities include Basin swamp, Mesic flatwoods, Wet flatwoods, Dome swamp, Depression marsh, Scrub, Baygall, and Scrubby flatwoods.

The preserve contains 7 threatened or endangered animal species and 6 plant species. These include Gopher tortoise, Florida black bear, Bald eagle, Gopher frog, Florida Mouse, Sherman's fox squirrel, and Bachman's sparrow; for plant, these include Rugel's false pawpaw, Celestial lily, Large-flowered rosemary, Hooded pircherplant, Catesby's lily, and Garberia(Florida Department of Agriculture and Consumer Services 2010).

Tomoka State Park

The Tomoka State Park in Volusia County is one of the oldest state parks in Florida's state park system. Its acquisition started since 1946 under the funding of The Land Acquisitions Trust Fund, Conservation and Recreation Lands, P2000 and Acquisition program. This park constitutes a peninsula with nearly 1,500 acres along the Tomoka River covering 10 different natural communities. The major communities include Salt marsh, Xeric hammock, and Mesic flatwoods.

The Tomoka State Park and Addison Blockhouse Historic State Park, Bulow Creek State Park, Bulow Plantation Ruins Historic State Park jointly provide home for 18 plants species and 19 animal species that are listed as threatened or endangered species(Florida DEP 2012).

Plants	**Animals**
Toothed spleenwort	American alligator
Eared spleenwort	Eastern indigo snake
Chapman's sedge	Gopher tortoise
Garberia	Atlantic salt marsh snake
Coastal mock vervain	Piping Plover
Angle pod	Little blue heron
Spiked crested coralroot	Reddish Egret
Southern twayblade	Snowy Egret
Cardinalflower	Tricolored Heron
Pigmypipes	White Ibis
Shell-mound pricklypear	Peregrine Falcon
Widespread polypody	American Oystercatcher

Plume polypody	Wood Stork
Comb polypody	Brown Pelican
Southern tubercled orchid	Roseate Spoonbill
Giant orchid	Black Skimmer
Levy pinkroot	Least tern
Giant airplant	Florida manatee
	Florida black bear

Waccasassa Bay Preserve State Park

The Waccasassa Bay Preserve State Park in Levy County contains 34,064 acres. It was initially acquired by the Trustees of the Internal Improvement Trust Fund of the State of Florida in 1971 under LATF and LWCF program. Additional acquisition was funded under P2000/A&I program, the CARL program, and other donations. The park contains 12 natural communities, and the dominant communities include Estuarine tidal marsh, Hydric hammock, Estuarine composite substrate, Basin swamp, and Mesic flatwoods.

There are 12 plants species and 9 animal species in the preserve that are listed as threatened or endangered species. These include Chapman's sedge, Wood spurge, Crested coralroot, Corkwood, Cardinal flower, Anglepod, Florida mayten, Erect prickly-pear, Pinewood dainties, Pinnate-lobed coneflower, Florida pinkroot, and Redmargin lily; the animal species include Loggerhead, Green turtle, Eastern indigo snake, Kemp's ridley, Florida scrub jay, Wood stork, Bald Eagle, Florida panther, Manatee, and Florida black bear(Florida DEP 2005).

Appendix B

Classifications and Definitions Found in Conservation Areas[1]

Hardwood Forested Uplands - Mesic or xeric forest dominated mainly by hardwood trees

Rockland Hammock - Flatland with limestone substrate; mesic; southern peninsula and Keys; rare or no fire; closed canopy of evergreen mixed tropical hardwoods; gumbo limbo, pigeon plum, stoppers

Scrub - Upland with deep sand substrate; xeric; statewide except extreme southern peninsula and Keys, mainly coastal in Panhandle; occasional or rare fire; open or dense shrubs with or without pine canopy; sand pine and/or scrub oaks and/or Florida rosemary. (FNAI)

Dry Prairie - Flatland with sand soils over an organic or clay hardpan; mesic-xeric; central peninsula; annual or frequent fire (1-2 years); treeless with a low cover of shrubs and herbs; wiregrass, dwarf live oak, stunted saw palmetto, bottlebrush threeawn, broomsedge bluestem.

Shrub and Brushland - Includes saw palmettos, gallberry, wax myrtle, coastal scrub and other shrubs and brush. Generally, saw palmetto is the most prevalent plant cover intermixed with a wide variety of other woody scrub plant species as well as various types of short herbs and grasses. Coastal scrub vegetation would include pioneer herbs and shrubs composed of such typical plants as sea purslane, sea grapes and sea oats without any one of these types being dominant.

Sandhill - Upland with deep sand substrate; xeric; panhandle to central peninsula; frequent fire (1-3 years); open canopy of longleaf pine and/or turkey oak with wiregrass understory.

Pine Flatwoods - Mesic pine woodland or mesic shrubland on flat sandy or limestone subtrates, often with a hard pan that impedes drainage

High Pine and Scrub - Hills with mesic or xeric woodlands or shrublands; canopy, if present, open and consisting of pine or a mixture of pine and deciduous hardwoods.

Scrubby Flatwoods - Flatland with sand substrate; xeric-mesic; statewide except extreme southern peninsula and Keys; occasional fire (5-15 years); widely scattered

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[1] Source: Kawula, R. (2012, December 2012). "Florida Land Cover Classification System Definitions for the Cooperative Land Cover Map v2.3." December 2012, from http://www.fnai.org/landcover.cfm.

pine canopy over saw palmetto and scrub oaks; longleaf pine, sand live oak, myrtle oak, Chapman's oak, saw palmetto, wiregrass.

Pine Rockland - Flatland with exposed limestone substrate; mesic-xeric; southern peninsula and Keys; frequent to occasional fire (3-7 years); open pine canopy with mixed shrubs and herbs in understory; south Florida slash pine, palms, mixed tropical and temperate shrubs, grasses, and herbs.

Upland Pine - Upland with sand/clay substrate; mesic-xeric; panhandle to extreme northern central peninsula; frequent fire (1-3 years); widely spaced canopy of pine over primarily herbaceous understory; longleaf pine and/or loblolly pine and/or shortleaf pine, southern red oak, wiregrass.

Mixed Hardwood-Coniferous - Mix of hardwood and coniferous trees where neither is dominant.

Coastal Uplands - Mesic or xeric communities restricted to barrier islands and near shore; woody or herbaceous vegetation; other communities may also occur in coastal environments.

Coastal Berm - Old bar or storm debris with sand/shell substrate; xeric-mesic; southern peninsula and Keys; rare or no fire; marine influence; variable vegetation structure; mixed tropical herbs, shrubs, and trees.

Coastal Strand - Stabilized coastal dune with sand substrate; xeric; peninsula; rare fire; marine influence; primarily dense shrubs; saw palmetto in temperate coastal strand or seagrape and/or saw palmetto in tropical coastal strand.

Maritime Hammock - Stabilized coastal dune with sand substrate; xeric-mesic; statewide but rare in panhandle and Keys; rare or no fire; marine influence; evergreen closed canopy; live oak, cabbage palm, red bay, red cedar in temperate maritime hammock; gumbo limbo, seagrape, and white or Spanish stopper in tropical maritime hammock.

Sand Beach (Dry) - Beaches are constantly affected by wave and tidal action. The fine clays and silts are washed away leaving sand. However, in protected bay and marsh areas, fine soil particles from surface drainage may settle out. The beach areas also are subject to water and wind erosion.

Human Influenced-Plantation - Four subclasses under this class are present in the study tracts: rural open pine, improved pasture, unimproved pasture, and tree plantations.

Rural Open Pine - Rural Open but with scattered to dense pines (FNAI).

Improved Pasture - This category in most cases is composed of land which has been cleared, tilled, reseeded with specific grass types and periodically improved with brush control and fertilizer application. Water ponds, troughs, feed bunkers and, in some cases, cow trails are evident.

Unimproved Pasture - Includes cleared or forest land with major stands of trees and brush where native grasses have been allowed to develop. Normally, this land will not be managed with brush control and/or fertilizer application.

Tree Plantations - Pine plantations that are artificially generated by planting seedling stock or seeds.

Freshwater Non-Forested Wetlands - Herbaceous or shrubby palustrine communities in floodplains or depressions; canopy trees, if present, very sparse and often stunted.

Prairies and Bogs - Short hydroperiod; dominated by grasses, sedges, and/or titi.

Wet Prairie - Flatland or slope with sand or clayey sand substrate; usually saturated but only occasionally inundated; statewide excluding extreme southern peninsula; frequent fire (2- 3 years); treeless, dense herbaceous community with few shrubs; wiregrass, blue maidencane, cutthroat grass, wiry beaksedges, flattened pipewort, toothache grass, pitcherplants, coastalplain yellow-eyed grass.

Marl Prairie - Flatland with marl over limestone substrate; seasonally inundated (<4 months); southern peninsula; frequent to occasional fire (2-10 years depending on density of herbs); purple muhly, sawgrass (stunted), spreading beaksedge, black bogrush, Florida little bluestem, and/or mixed grasses, sometimes with dwarf cypress.

Freshwater Marshes - Long hydroperiod; dominated by grasses, sedges, broadleaf emergents, floating aquatics, or shrubs. (FNAI)

Coastal Intertudunal Swale - Linear wetlands between dunes on sandy barrier islands; inundated by local rainfall events; Panhandle to central peninsula; herbaceous or shrubby; sawgrass, hairawn muhly, broomsedge, seashore paspalum, Baker's cordgrass, saltmeadow cordgrass, wax myrtle, coastalplain willow.

Floodplain Marsh - Floodplain with organic/sand/alluvial substrate; seasonally inundated; Panhandle to central peninsula; frequent or occasional fire (ca. 3 years, much less frequent in freshwater tidal marshes); treeless herbaceous community with few shrubs; sawgrass, maidencane, sand cordgrass, and/or mixed emergents.

Freshwater Forested Wetlands - Floodplain or depression wetlands dominated by hydrophytic trees.

Strand Swamp - Broad, shallow channel with peat over mineral substrate; situated in limestone troughs; seasonally inundated; slow flowing water; vicinity of Lake Okeechobee southward in the central and southern peninsula; occasional or rare fire; closed canopy of cypress and mixed hardwoods; cypress, pond apple, strangler fig, willow, abundant epiphytes.

Other Coniferous Wetlands - Coniferous forested wetlands that are not dominated by cypress, tupelo, or a mix of cypress/tupelo.

Wet Flatwoods - Flatland with sand substrate; seasonally inundated; statewide except extreme southern peninsula and Keys; frequent fire (2-4 years for grassy wet flatwoods, 5-10 years for shrubby wet flatwoods); closed to open pine canopy with grassy or shrubby understory; slash pine, pond pine, large gallberry, fetterbush, sweetbay, cabbage palm, wiregrass, toothache grass.

Mixed Wetland Hardwoods - Wetland hardwood communities which are composed of a large variety of hardwood species tolerant of hydric conditions yet exhibit an ill defined mixture of species.

Hydric Hammock - Lowland with sand/clay/organic soil over limestone or with high shell content; mesic- hydric; primarily eastern Panhandle and central peninsula; occasional to rare fire; diamond-leaved oak, live oak, cabbage palm, red cedar, and mixed hardwoods.

Other Wetland Forest-Mixed - Includes mixed wetlands forest communities in which neither hardwoods or conifers achieve a 66 percent dominance of the crown canopy composition.

Non-Vegetated Wetland - Hydric surfaces on which vegetation is found lacking due to the erosional effects of wind and water transporting the surface material so rapidly that the establishment of plant communities is hindered or the fluctuation of the water surface level is such that vegetation cannot become established. Additionally, submerged or saturated materials often develop toxic conditions of extreme acidity. Intermittent ponds are the main components of this category.

Altered Wetlands - Communities that are both created and maintained by human activities, or are modified by human influence to such a degree that the physical conformation of the substrate, the hydrology, or the biological composition of the resident community is substantially different from the character of the substrate, hydrology, or community as it existed prior to human influence.

Wet Coniferous Plantations - This land cover is hydric pine flatwoods and land use is coniferous plantation.

Natural Lakes and Ponds - Includes inland lakes and ponds in which the trophic state, morphometry, and water chemistry have not been substantially modified by human activities, or the native biota are dominant.

Natural Rivers and Streams - Streams in which the stream flow, morphometry, and water chemistry have not been substantially modified by human activities, or the native biota are dominant.

Estuarine - Deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the ocean, with ocean-derived water at least occasionally diluted by freshwater runoff from the land. The upstream and landward limit is where ocean-de rived salts measure less than .5 ppt during the period of average annual low flow. The seaward limit is (1) an imaginary line closing the mouth of a river, bay, or sound; and (2) the seaward limit of wetland emergents, shrubs, or trees when not included in (1).

Keys Tidal Rock Barren - Flatland with exposed limestone in supratidal zone; restricted to Keys; no fire; open, mainly herbaceous vegetation of upper tidal marsh species and stunted shrubs and trees; buttonwood, christmasberry, perennial glasswort, saltwort, seashore dropseed, shoregrass.

Saltwater Marsh - Estuarine wetland communities having a representative suite of salt tolerant plant species, listed below. Periods of inundation are dictated by tidal fluctuations, with landscape positions stretching from tidal flats to near uplands boundaries. The FLUCCS manual provides the following list of characteristic saltwater marsh species: Cordgrasses, Needlerush, Seashore Saltgrass, Saltwort, Glassworts, Fringerush, Salt Dropseed, Seaside Daisy, and Salt Jointgrass.

Mangrove (Swamp) - Coastal hardwood community is composed of red and/or black mangrove which is pure or predominant. The major associates include white mangrove, buttonwood, cabbage palm and sea grape.

Marine - Open ocean overlying the continental shelf and coastline exposed to waves and currents of the open ocean shoreward to (1) extreme high water of spring tides; (2) seaward limit of wetland emergents, trees, or shrubs; or (3) the seaward limit of the Estuarine System, other than vegetation. Salinities exceed 30 parts per thousand (ppt).

Exotic Plants - Upland and wetland areas dominated by non-native trees that were planted or have escaped and invaded native plant communities. These exotics include melaleuca, Australian pine, Brazilian pepper, and eucalyptus. This class includes sites known to be vegetated by non-native but for which the actual species composition could not be determined. (Kawula 2012)

Appendix C

Methods and Ecosystem Services in Primary Studies

	Reference	Valuing Method	Year	Location	Primary Ecosystem Service Being Valued
Hardwood Forested Uplands	(AbdElraman, Adams et al. 2012)	WTP, Avoidance costs	2010	Florida	Water purification, Carbon stocks, Wildlife, Timber
Scrub and Dry Prairie	(AbdElraman, Adams et al. 2012)	WTP, Avoidance costs	2010	Florida	Wildlife
Pine Flatwoods	(AbdElraman, Adams et al. 2012)	WTP, Avoidance costs	2010	Florida	Water purification, Carbon stocks, Wildlife, Timber
Mixed Hardwood-coniferous	(AbdElraman, Adams et al. 2012)	WTP, Avoidance costs	2010	Florida	Water purification, Carbon stocks, Wildlife, Timber
Coastal Uplands	(Petrolia and Kim 2009)	WTP	2009	Mississippi	Protection
Human Influenced Plantation	(AbdElraman, Adams et al. 2012)	WTP, Avoidance costs	2010	Florida	Water purification, Carbon stocks, Wildlife, Timber
Freshwater Non-Forested Wetlands	(Yoskowitz, Carollo et al. 2012)	Meta-analysis	2012	Multi-location	Recreation, Waste Regulation, Disturbance Regulation, Food, Aesthetics
Freshwater Forester Wetlands	(AbdElraman, Adams et al. 2012, Yoskowitz, Carollo et al. 2012)	Meta-analysis	2012, 2010	Multi-location	Recreation, Waste Regulation, Disturbance Regulation, Food, Aesthetics
Natural Lakes and Ponds	(Takatsuka 2004)	WTP	2004	Tennessee	Water quality, Wildlife habitat, recreation
Natural Rivers and Streams	(Takatsuka 2004)	WTP	2004	Tennessee	Water quality, Wildlife habitat, recreation
Estuarine	(Johnston, Grigalunas et al. 2002)	Productivity Value Model	2002	New York	Habitat
Mangrove	(Jerath 2012)	Avoidance costs	2012	Indonesia	Carbon stocks
Marine	(Bishop, Chapman et al. 2011)	WTP	2011	Hawaii	Wildlife, fisheries